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(56) Documents cited
GB 2161309 A GB 1522520 A EP 0208283 A1
WO 88/02530 A1 US 4798448 A US 4679044 A
US 4630895 A US 4618216 A US 4487481 A
US 4121206 A US 3644922 A

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(54) Liquid crystal displays

(57) A device (1) for backlighting a liquid crystal display panel (9) comprises a high-intensity light source (10), a preferably wedge-shaped plate (2) which is located behind the panel to act as a light guide, and a bundle of optical fibres (13) coupling the light source to respective points along an edge (5) of the plate. The configuration allows the light source to be positioned away from the panel, thereby reducing the overall thickness of the panel assembly and removing from the panel region the source of heat constituted by the light source.

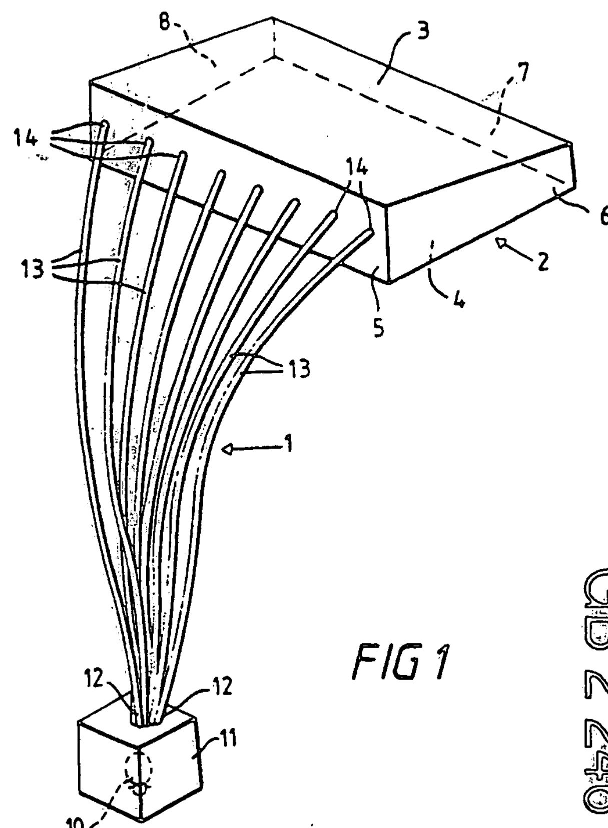

FIG 1

At least one drawing originally filed was informal and the print reproduced here is tak n from a lat r filed formal copy.

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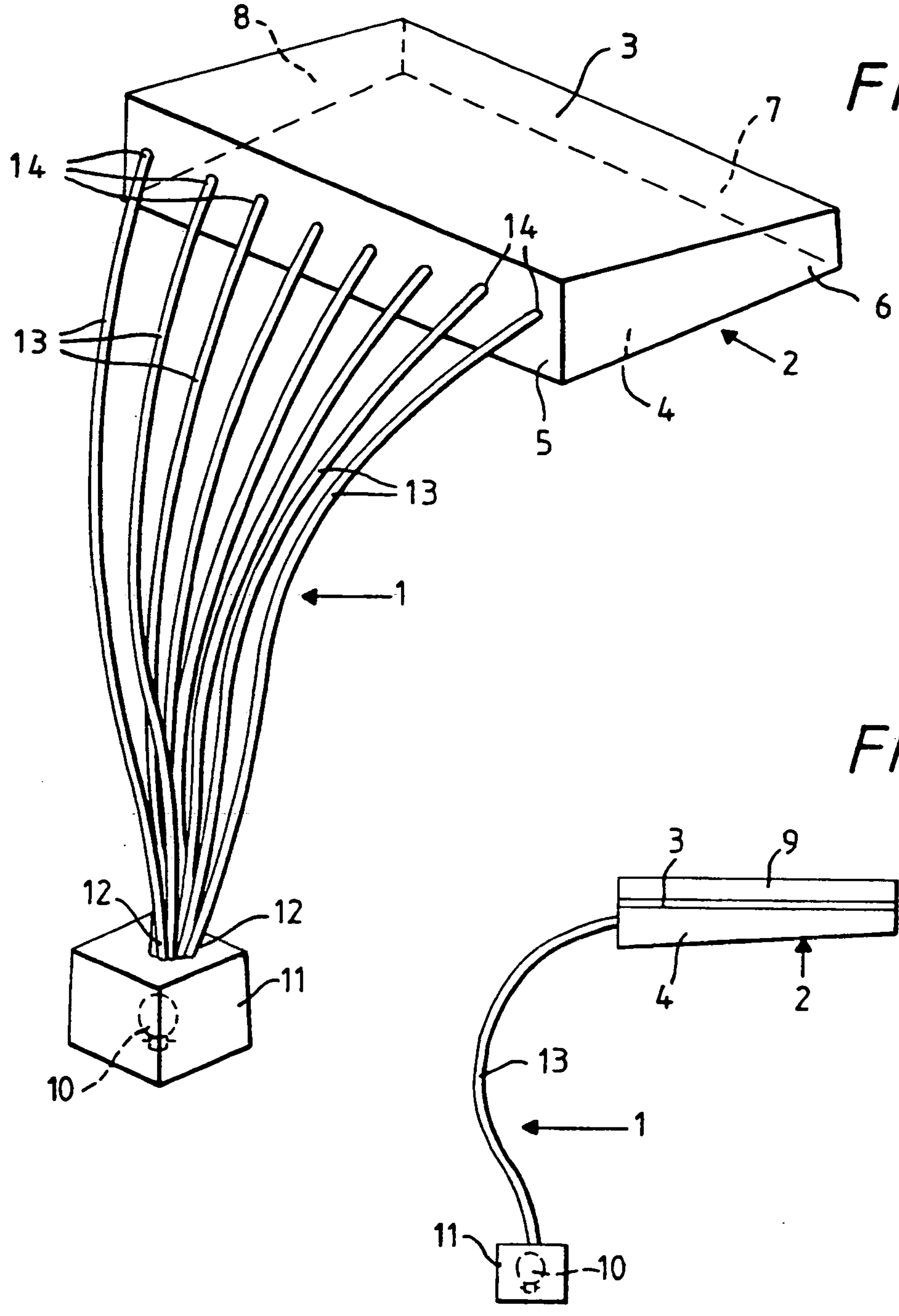
FIG 1

FIG 2



Liquid Crystal Displays

This invention relates to liquid crystal displays, and particularly to a light source for backlighting a liquid crystal display (LCD).

In the transmitting mode of operation of an LCD, light passes through the liquid crystal cells from a light source disposed behind the display, i.e. on the side of the display panel remote from the viewer.

There is a requirement to provide such a light source which will produce a luminance of at least 100fL at the viewed face of the LCD; which will have a thickness no greater than about 6mm; which will preferably be compatible with the NVIS (night vision) specification, i.e. the light output wavelength will not extend beyond 600nm; and the brightness of which can preferably be easily controlled.

The conventional light sources do not satisfy all of these requirements. The following Table 1 indicates the luminance values and the thicknesses of the various conventional light sources, together with comments on their suitability for the present purpose.

Table 1

Light Source	Luminance (fL)	Thickness (mm)	Comment
Cold cathode fluorescent tube	730	3.8	Standard lengths of fluorescent tubes are 50 and 150 mm.
Hot cathode fluorescent tube	2000	8	Too thick.
Optical fibre mat	220	~ 2	Too dim.
Electroluminescent panel	20	~ 1	Too dim.
Light-emitting diodes + diffuser	Low	3-5	Too dim.

Bearing in mind that the light transmission efficiency of a liquid crystal display and its associated components is only about 5 to 10%, a source luminance of 1000-2000 fL or greater is required. From the table it will be seen that only one type of light source will provide a sufficiently high luminance, namely the hot cathode fluorescent tube. However, even the smallest tube of this type is too thick for the present purposes. Four of the light source types are sufficiently thin. Of these, the brightest is the cold cathode fluorescent tube, but it is nevertheless too dim, it would require a 30mm space for accomodation of its electrodes beyond the edges of the LCD, it would require the provision of a diffuser located between it and the LCD, and it would have to be made specially to suit the size

of the particular LCD, as only standard lengths of tube are readily available. The fibre optic mat has the highest luminance of the other three sources, but it is too low by a factor of 5 to 10.

It is an object of the present invention to provide an improved backlighting source for a liquid crystal display.

According to the invention there is provided a device for backlighting a liquid crystal display panel, the device comprising light producing means for producing high-intensity light; a light-conductive plate having a major surface of substantially the same dimensions as the display panel area to be illuminated, the plate in use acting as a light guide whereby light fed into an edge of the plate emerges from said major surface; and a plurality of optical fibres each coupled at one of its ends to the light producing means and at its other end to a respective point on said edge of the plate, the points being spaced apart along said edge, in order to provide a more uniform light source.

Preferably the plate is tapered so that said major surface and the opposite major surface of the plate are convergent in a direction away from said edge, in order to provide a more uniform light source.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawing, in which

Figure 1 is a schematic pictorial view of a backlighting device in accordance with the invention, and

Figure 2 is a schematic side view of the device coupled to an LCD panel.

Referring to Figures 1 and 2 of the drawing, a backlighting device 1 comprises a light-conductive plate 2 having opposing major surfaces 3 and 4 and edges 5 to 8. The surface 3 is substantially the same area as an LCD panel 9 which is to be illuminated. In use, the surface 3 is located in contact with, or closely-spaced from, the rear of the panel 9. The plate 2 is tapered so that the surfaces 3 and 4 converge in a direction away from the edge 5. The maximum

thickness of the plate, i.e. between the surfaces 3 and 4 at the edge 5, is preferably about 6mm or less.

A high-intensity light source 10, such as, for example, a filament lamp, a laser, a fluorescent tube or an array of light-emitting diodes, is coupled, via an optical coupler 11, to the ends 12 of a bundle of optical fibres 13. The other ends 14 of the fibres 13 are coupled to the edge 5 of the plate 2 at respective points which are spaced apart along the edge. The coupler may comprise, for example, a block of suitable plastics material.

The plate 2 acts as a light guide so that light fed from the source 10, along the optical fibres 13, and into the edge 5 emerges from the surface 3. The surface 4 and/or the edges 6, 7, 8 and 5 (between the fibre coupling points) of the plate 2 may be coated with reflective layers. The plate is so designed that the light emitted from the surface 3 has a substantially uniform brightness over the area of the surface. For this reason the plate is preferably wedge-shaped, as shown.

It will be apparent that the light source 10 can be spaced away from the plate 2 and the LCD panel 9 by an appreciable distance, so that heat dissipation problems normally associated with a high-intensity light source, and particularly its proximity to the LCD panel, are alleviated. Since the light source no longer has to be accommodated immediately behind the LCD panel 9, the shape and size of the light source become far less significant, and standard components, such as fluorescent tubes of standard sizes, can be used. If controllable dimming of the display and/or NVIS compatibility are required, the type of light source can be selected accordingly.

If an elongate light source, such as a fluorescent tube, is used, the coupler 11 may be made similarly elongate, and the ends 12 of the optical fibres 13 may then be connected to the coupler 11 at spaced apart points along the coupler.

If necessary, the ends 14 of the optical fibres may be coupled to the edge 5 of the plate 2 in more than one row, the positions of the ends 14 in the rows being staggered.

Although the plate 2 is described above as having planar surfaces and being tapered in a direction away from the edge 5, it may be of any shape which will provide the required light-guiding function, while still being within the described thickness range.

All of the optical fibres in the described embodiment are coupled to a single light source 10. It would, however, be possible to divide the fibres into a number of groups and to couple each group to a respective light source. Alternatively, each individual fibre might be coupled to a respective light source.

CLAIMS

1. A device for backlighting a liquid crystal display panel, the device comprising light producing means for producing high-intensity light; a light-conductive plate having a major surface of substantially the same dimensions as the display panel area to be illuminated, the plate in use acting as a light guide whereby light fed into an edge of the plate emerges from said major surface; and a plurality of optical fibres each coupled at one of its ends to the light producing means and at its other end to a respective point on said edge of the plate, the points being spaced apart along said edge.
2. A device as claimed in Claim 1, wherein the plate is tapered so that said major surface and the opposite major surface of the plate are convergent in a direction away from said edge.
3. A device as claimed in Claim 1 or Claim 2, including means for varying the brightness of the light producing means.
4. A device as claimed in any preceding claim, wherein the light producing means comprises at least one filament lamp.
5. A device as claimed in any one of Claims 1-3, wherein the light producing means comprises at least one laser.
6. A device as claimed in any one of Claims 1-3, wherein the light producing means comprises a plurality of light-emitting diodes.
7. A device as claimed in any one of Claims 1-3, wherein the light producing means comprises at least one fluorescent tube.
8. A device as claimed in Claim 7, wherein the ends of the optical fibres are coupled to the fluorescent tube by means of an elongate coupling device, the ends being spaced apart along said coupling device.
9. A device for backlighting an LCD panel, substantially as hereinbefore described with reference to the accompanying drawing.

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